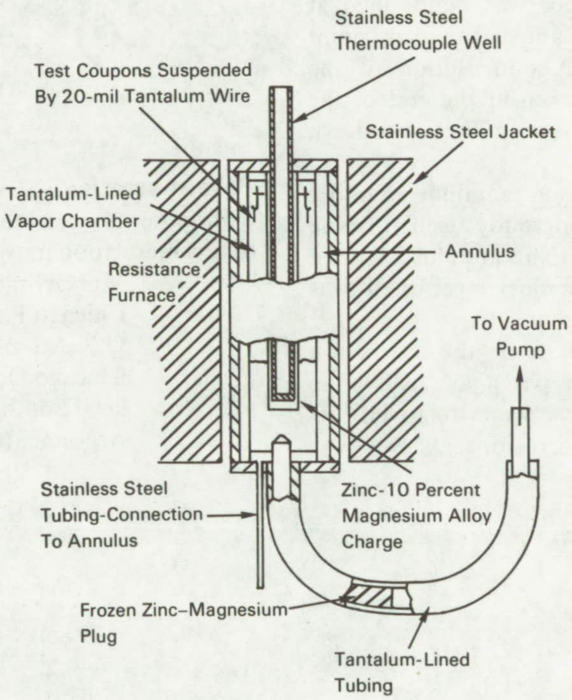
AEC-NASA TECH BRIEF

Study Made of Resistance of Stainless Steels to Zinc-Vapor Corrosion



The problem:

To determine the applicability of stainless steels for equipment which would be exposed only to zinc vapor, and not to zinc liquid. In recovering and purifying discharged reactor-fuel materials, the very corrosive zinc and zinc-rich alloys are employed as solvent media. Tantalum and tungsten vessels are used to hold the liquid zinc alloys; these vessels in turn are housed in stainless steel equipment. Although all stainless steels are severely attacked by liquid zinc, it has been observed that 304 stainless steel suffers little attack by zinc vapor at temperatures to about 800°C.

The solution:

A study of the corrosion resistance of several stainless steels to zinc vapor revealed that some stainless steels could be employed for use in zinc processing equipment housings or vapor lines. The stainless steels investigated were Types 405, 440C, 304, and 347. Type 405, a ferritic steel, appears definitely superior to the other steels tested in withstanding attack by zinc vapor. Type 440C, a martensitic steel, suffered considerable weight loss, but no other discernible effects. Two austenitic stainless steels, Types 304 and 347, suffered severe intergranular attack and loss of nickel due to probable formation

(continued overleaf)

of low melting, zinc-rich phases. Thus, from the standpoint of structural integrity, both of the 400-series steels (405 and 440C) offer better resistance to attack by zinc vapor than do the 300-series steels.

How it's done:

The stainless steel test coupons were exposed to static zinc vapor for 500 hours at temperatures about 900°C. The apparatus, shown in the figure, consisted of a closed tantalum tube, jacketed in Type 304 stainless steel to prevent oxidation of the tantalum. A Zn-10 wt-pct Mg alloy charge in the bottom of the tube was maintained at about 740°C and provided zinc vapor at a partial pressure of about 70 mm Hg.

Four weighed and measured stainless steel coupons were suspended in the vapor space in the upper part of the tantalum tube. This space was maintained at 890° to 900°C, about 150°C above the dew point of the zinc vapor, to prevent condensation of the zinc vapor. Precautions were taken at the end of the run to prevent condensation during the cool-down phase.

Throughout the run, the inner tantalum chamber was under vacuum, with the zinc alloy itself forming a freeze seal in the outlet tube. The annulus between the tantalum tube and the stainless steel shell was pressurized with high purity argon.

At the conclusion of the test, the corrosion apparatus was sawed into two parts just below the test coupons, and the coupons were removed for determination of the extent of corrosion.

Notes:

1. This information should be of general interest to the steel industry, and may be of specific interest to zinc alloy manufacturers, and to manufacturers of galvanized equipment, sheets, and parts.
2. Additional details are contained in *Transactions of the Metallurgical Society of AIME*, vol. 233, May 1965, pp. 1032–1036.
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B67-10582

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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U.S. Atomic Energy Commission
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